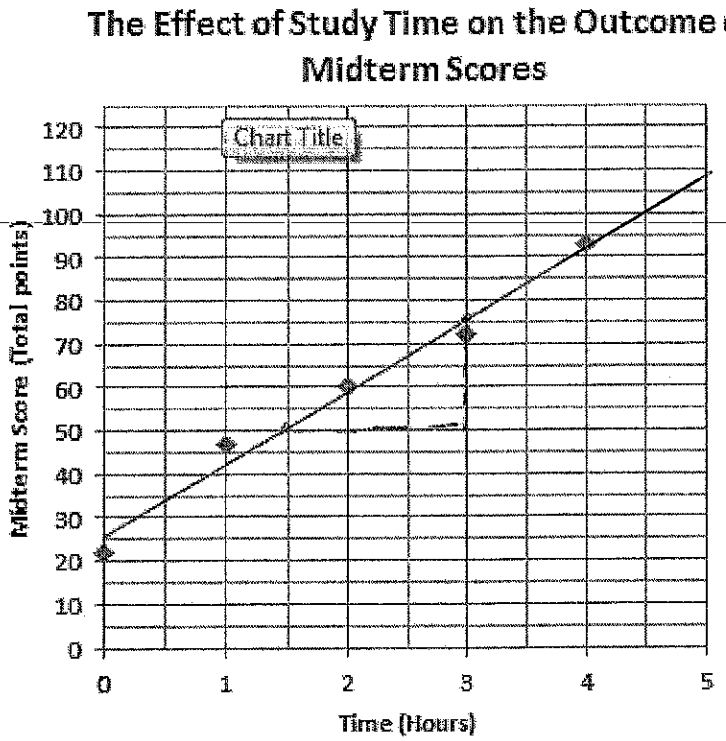
Chem 311 -- Midterm Review Practice Problems

Chapter 1: Introduction to Chemistry

Examine the following graph and answer the questions that follow



1. What is the dependent variable? midterm score

2. What is the relationship between study time and midterm scores? direct

3. Based on the trend line, what is the average increase in point value per hour?

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{75-50}{3-1.5} = \frac{25}{1.5} = 17 \text{ points/hr}$$

* either interpolate or solve linear equation.

4. What score could one expect to receive after studying for 2.5 hours? 67.5 points

$y = 17x + 25$

5. Using extrapolation, determine the amount of time one would have to study to get a score of 100 on the midterm? 4.5 hours * extend the line

Chapter 2: Matter and change

1. Using one of the following terms: *element*, *compound*, *solution*, or *heterogeneous mixture*, classify the following materials.

   a. methane gas (CH_4) — *Answer:* compound

   b. sugar dissolved in water — *Answer:* solution

   c. Air — *Answer:* solution

   d. Granite — *Answer:* heterogeneous mixture

   e. Brass — *Answer:* solution

   f. Zirconium — *Answer:* element

2. Determine whether the following properties are physical or chemical, and intensive or extensive by placing an "X" in the appropriate boxes.

Property	Physical	Chemical	Intensive	Extensive
Density	X		X	
Conductivity	X		X	
Mass	X			X
Color	X		X	

3. Determine whether the following processes represent physical or chemical changes by placing an "X" in the appropriate box.

Process	Physical	Chemical
Filtration	X	
Decomposition		X
Change in color		X
Crystallization	X	

4. Determine whether the processes are endothermic or exothermic by placing an "X" in the appropriate box.

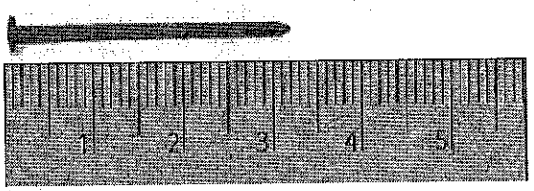
Process	Endothermic	Exothermic
Freezing of Bromine		X
An explosion		X
Boiling of water	X	

5. Record the technique and property which would be used to separate the following mixtures

Mixture	Technique	Property
A solution of salt water (to yield salt crystals)	crystallization	solubility
A solution of alcohol and water	distillation	boiling point
Spaghetti in a pot of water	filtration	particle size

Chapter 3: Scientific Measurement

1. How long is this nail? 3.19 (each line represents 0.1 cm)



always measure one digit beyond (estimate)

2. How many significant digits are there in the following measurements?

10.0600 cm 6 b. 0.00068050 pg 5 c. 653000 m 3 d. 1.860×10^{15} L 4

3. Perform the following calculations and round your answers to the correct number of significant figures.

$(6.8 \times 10^{23})(2 \times 10^{-8})$ $\quad 1.05 \times 10^{4} + 9.8 \times 10^{3}$ $\quad 4.32 \times 10^{-4} / 6.5 \times 10^{-12}$

$13.6 \times 10^{15} \rightarrow 1.36 \times 10^{16}$ $\quad 2.03 \times 10^{4} \rightarrow 2.0 \times 10^{4}$ $\quad 0.664615385 \times 10^{8} \rightarrow 6.6 \times 10^{7}$

4. Perform the following conversions using the factor label method. Report your answer in proper **scientific notation with the correct number of sig figs.**

1.0 kg = 2.2 lb	*1.0 L = 34.0 oz*	*3 ft = 1 yd*	*1.6km = 1 mi*
1.0 in = 2.54 cm	*1.0 m = 1.13 yd*	*5280 ft = 1 mi*	*12 in = 1 ft*

a. How many yards are equal to 0.680 km?

$$0.680\,\text{Km}\left(\frac{1000\,\text{m}}{1\,\text{Km}}\right)\left(\frac{1.13\,\text{yd}}{1\,\text{m}}\right) =$$

Answer: 768 yd.

b. How many picoliters are there in 0.00018oz

$$0.00018\,\text{oz}\left(\frac{1\,\text{L}}{34.0\,\text{oz}}\right)\left(\frac{1\times10^{12}\,\text{pL}}{1\,\text{L}}\right) =$$

Answer: 5.3×10^{7} pL

c. Light travels at 3.00×10^{8} m/s; what speed is that in mi/hr ?

$$\frac{3.00\times10^{8}\,\text{m}}{\text{s}}\left(\frac{1\,\text{Km}}{1000\,\text{m}}\right)\left(\frac{1\,\text{mi}}{1.6\,\text{Km}}\right)\left(\frac{60\,\text{s}}{1\,\text{min}}\right)\left(\frac{60\,\text{min}}{1\,\text{hr}}\right) =$$

Answer: 6.75×10^{8} mi/hr

5. What is the relationship between the following variables?

Density and Mass direct Mass and Volume direct Density and Volume inverse

6. Calculate the volume of a gold brick in Liters with the dimensions of 3.5 cm x 5.0 cm x 23.2 cm. Gold has a density of 19.3g/ml.

D

$$3.5\,\text{cm} \times 5.0\,\text{cm} \times 23.2\,\text{cm}\left(\frac{1\,\text{mL}}{1\,\text{cm}^3}\right)\left(\frac{1\,\text{L}}{1000\,\text{mL}}\right) = 0.4\,\text{L}$$

7. What is the mass of chlorine gas that would fill a 250 ml jar at 25°C? The density of Cl_2 at 25°C is 2.994 kg/m^3.

$D = \frac{m}{V}$ $\quad M = DV$

$$\frac{2.994\,\text{Kg}}{\text{m}^3}\left(\frac{1\,\text{m}}{100\,\text{cm}}\right)^3\left(\frac{1\,\text{cm}^3}{1\,\text{mL}}\right)\left(\frac{250\,\text{mL}}{1}\right) = 0.00075\,\text{g}$$

8. A beaker is filled to the 250.0 mL line and then poured into a graduated cylinder. The cylinder, being a more precise instrument, shows that the volume is 243.50 mL. What is the percent error in the measurement using the beaker? (assume that the value recorded for the cylinder is your accepted value).

$$\left|\frac{250.0 - 243.50}{243.50}\right| = \frac{6.50}{243.50} \times 100 = 2.7\%$$

(6.50 — least decimal)

Chapter 4: Atomic Structure

1. Complete the following table for the most common isotope

Atomic Number	*Mass Number*	*Number of Protons*	*Number of Neutrons*	*Number of Electrons*
8	16	8	8	8
7	14	7	7	7
20	41	20	21	20

2. Atomic Mass

The relative abundances of the isotopes of palladium are given below. Using this data calculate the average atomic mass of palladium. You will only be given credit if you show all your work. Follow all significant figure rules.

Pd-102	101.9056	amu	1.02 % 1.039437 1/2
Pd-104	103.9040		11.14 11.57496 52
Pd-105	104.9051		22.33 23.42530883
Pd-106	105.9035		27.33 28.94342655
Pd-107	107.9039		26.46 28.55137194
Pd-110	109.9052		11.72 12.88088144

+

Answer: 106.41534

Chapter 25: Nuclear Chemistry

1. Write the following decay reactions:

a. Alpha decay of Pu-250 $^{250}_{94}Pu \rightarrow {}^{4}_{2}He + {}^{246}_{92}U$

b. Beta decay of Ca-45 $^{45}_{20}Ca \rightarrow {}^{0}_{-1}\beta + {}^{45}_{21}Sc$

c. Electron capture by S-28 $^{28}_{16}S + {}^{0}_{-1}e \rightarrow {}^{28}_{15}P$

d. Positron emission by Sc-41 $^{41}_{21}Sc \rightarrow {}^{0}_{+1}\beta + {}^{41}_{20}Ca$

2. Solve the following half-life problems.

a. What is the half-life of Zr-110 if it takes 1.6 seconds for 120.0 g of the isotope to decay to 7.5 g?

$\frac{\text{final}}{\text{initial}} = (1/2)^n$ $\quad \frac{7.5\,g}{120\,g} = \left(\frac{1}{2}\right)^n \cdot \quad \frac{1}{16} = \left(\frac{1}{2}\right)^4$

Answer: 0.4 s

$n = \frac{\text{Time}}{t_{1/2}}$ $\quad \frac{1.6}{4} = 0.4$ $\quad n = 4$

b. How long would it take an isotope to decay from 3.0g to 0.75g if its half-life 3.24×10^6 years?

$\frac{\text{final}}{\text{initial}} = \left(\frac{1}{2}\right)^n \quad \frac{0.75}{3.0} = \left(\frac{1}{2}\right)^n \quad \frac{1}{4} = \frac{1}{2}^n \quad n = 2$

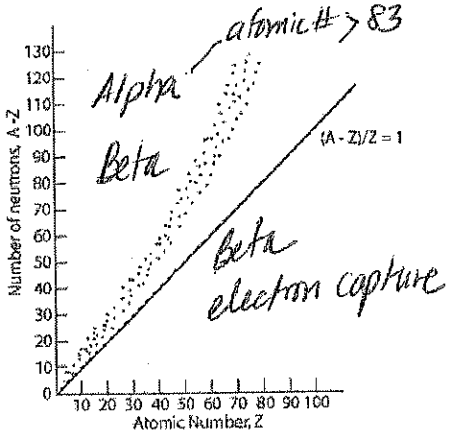
$2 \times 3.24 \times 10^6 \text{ yr}$ Answer: $6.48 \times 10^6 \text{ yr}$

c. What amount of a 40.2g sample of I-130 would remain after 12 years if it's half-life is 18 months?

$\frac{x}{40.2g} = \left(\frac{1}{2}\right)^{\frac{144}{18}}$

$\frac{x}{40.2g} = \frac{1}{256} \quad x = 0.157g$ Answer: 0.157g

3. Refer to the band of stability graph to answer the following questions:



a) Given the band of stability diagram, what type of decay would Zr-110 undergo? Zr-110 $n = 70$ $p = 40$

$\frac{n}{p} = 1.8$ (way above) Beta

b) Write the equation for the decay of Zr-110 given your answer in (b) and circle the daughter nucleus in the equation.

$^{110}_{40}Zr \rightarrow {}^{0}_{-1}\beta + {}^{110}_{41}Nb$

4. Write the following induced transmutation reactions:

a. Iron-60 undergoes alpha bombardment and produces two neutrons in addition to its daughter nuclide.

$^{60}_{26}Fe + {}^{4}_{2}He \rightarrow 2\,{}^{1}_{0}n + {}^{62}_{28}Ni$

b. Potassium-46 undergoes beta bombardment and produces three neutrons, chlorine-43 and what other particle?

$^{46}_{19}K + {}^{0}_{-1}\beta \rightarrow 3\,{}^{1}_{0}n + {}^{43}_{17}Cl + {}^{0}_{+1}\beta$

Chapter 5: Electrons in Atoms

1. Answer the following questions using the information given below. Be sure to report your answer in **scientific notation.** (7 pts)

$c = 3.00\times10^{8}$ m/s $h = 6.626\times10^{-34}$ Js $E = h\nu$ $c = \lambda\nu$ $1\ m = 1\times10^{9}$ nm

a. What is the wavelength, in meters, of light with a frequency of 7.32×10^{19} Hz?

$c = \lambda\nu$

$\lambda = \frac{c}{\nu}$ $\frac{3.00\times10^{8}\ m}{s} \cdot \left(\frac{s}{7.32\times10^{19}}\right) =$

Answer: 4.10×10^{-12} m

b. What is the energy of a photon of light with a frequency of 2.98×10^{7} Hz?

$E = h\nu$ $E = 6.626\times10^{-34}\ J\cdot s \left(\frac{2.98\times10^{7}}{s}\right) =$

Answer: 1.97×10^{-26} J

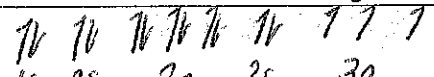
c. Which of the two waves above has greater energy? Support your answer using either math or a written explanation.

Energy and Frequency are directly related so...
A with a frequency of 7.32×10^{19} Hz has a greater energy than B that has a frequency of only 2.98×10^{7} Hz.

d. What is the relationship between:

E and ν direct λ and ν inverse E and λ inverse

2. Answer the following questions regarding electron structure of the following elements

ELEMENT	Orbital Dot Diagram	Noble Gas Electron Configuration
P		[Ne] $3s^2 3p^3$
Na		[Ne] $3s^1$
Nb	1 1 1 4d — Too big for whole diagram	[Kr] $5s^2 4d^3$
Ho	Too big to fit here	[Xe] $6s^2 5d^1 4f^{10}$

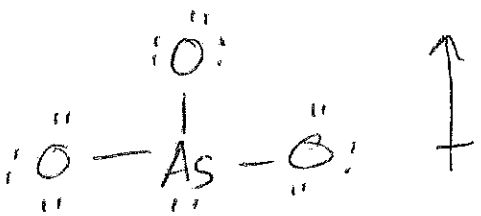
Chapter 6 and 7.1: The Periodic and Ionic and Metallic Bonding

1. Fill in the following table with the correct information.

Element	Chemical Family	Block	Lewis Dot Structure	Most common ion
Strontium	Alkaline Earth	s	$Sr\cdot$	Sr^{2+}
Iodine	halogen	p	$:\ddot{I}:$	I^{1-}
Lead	other metal	p	$\cdot\dot{P}b\cdot$	Pb^{4+}
Chromium	transition metal	d		
Berkelium	inner transition metal	f		
Antimony	metalloid	p	Sb	
Rubidium	Alkali metal	s	$Rb\cdot$	Rb^{+}
Sulfur	non-metal	p	$:\ddot{S}:$	S^{2-}

Chapter 8: Covalent Bonding

1. Draw the structural formula for AsO_3^{3-} (arsenite ion)

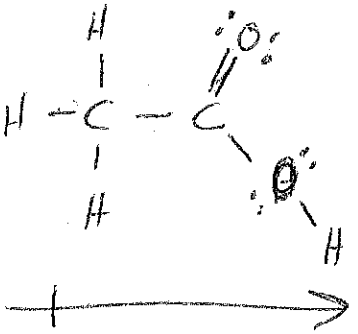


What is it's shape?

Is it polar or non-polar? yes
(if so, show the direction of polarity

2. Draw the structural formula for $C_2H_4O_2$ (ethanoic acid)

$12 - 24 = 16/2 = 8$



Is it polar or non-polar?
(if so, show the direction of polarity) yes